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(71) Applicant *(for all designated States except US)*: ORTIC AB [SE/SE]; Tunavägen 290, S-781 73 Borlänge (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: INGVARSSON, Lars [SE/SE]; Myntgatan 3; S-784 54 Borlänge (SE). RUDMAN, Lars [SE/SE]; Åsögatan 169, S-116 32 Stockholm (SE).

(74) Agent: ÅSLUND, Roland; Avesta Patentbyrå, PO Box 99, S-775 01 Krylbo (SE).

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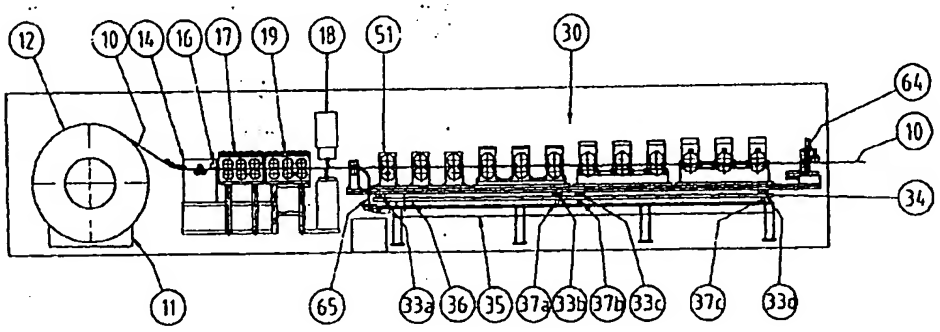
(54) Title: A ROLL FORMING MACHINE



(57) Abstract: A roll-forming machine includes in line a device (11) for unwinding metal strip (10) from a strip reel (12), a strip cutter (18), and a roll-forming section (30; 90). The roll-forming section includes a row of forming stations that include forming rolls that are carried by shafts which are supported on a respective one side of the sheet section. Each row of forming stations includes an edge cutter (58, 59; 102, 103) and a first forming station mounted on a common movable carrier (31, 32; 100, 101), for collective movement. The angle of the carrier relative to the longitudinal axis of the forming section can be adjusted and the carrier can be moved in a parallel manner transversely to said longitudinal axis so as to enable said movement and said angular adjustment of these forming stations to be achieved simultaneously.

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A ROLL FORMING MACHINE

FIELD OF INVENTION

The present invention relates to a machine which comprises forming/shaping rolls and which includes in a line means for unreeling sheet-metal strip from a reel of strip, strip cutters, and a roll-equipped sheet-forming section.

DESCRIPTION OF THE BACKGROUND ART

One method of covering roofs with thin metal roofing sheet includes the use of standing seams, i.e. seams that are of a height such as to always extend above any water that may be present on the roof. Seams are known which are snapped together without being squeezed, for instance the seams according to U.S. 5,519,974 and U.S. 5,535,567 wherein after having been placed together, the sheets are interlocked either with or without a sealing strip in respective seams, as illustrated in U.S. 6,115,899, for instance. The sheets are fastened to the roof in said seams, therewith avoiding through-penetrating nails or screws. Known machines for roll-forming the seam-forming edges can normally only shape the edges on sheeting of uniform width. Transverse seams are undesirable, and it is possible to produce long sheets in this way. Long roofing sheets are sometimes produced with a machine that is lifted onto the roof. This enables direct production of roofing sheets that are able to cover a very wide roof, said sheets being taken from a strip-carrying reel. Because production is carried out on the roof, it is possible to handle sheets that are several tens of metres in length.

JP 905 21 25 illustrates a machine that can roll-shape the edges of sheets that taper towards one end thereof. Such sheets are used, for instance, to cover the roofs of circular buildings. However, this machine can only handle piece-wise sheets that have been cut and edged in other equipment.

OBJECT OF THE INVENTION

An object of the present invention is to provide a machine that will enable roll-forming and/or roll-shaping of long sheets that need not necessarily have a constant uniform width, directly the sheets are cut from the strip. In principle, this object is achieved with a machine of the aforesaid kind in which the roll-forming section includes a line of forming stations that include forming rolls supported one-sided by shafts on respective sides of the sheet travelling path, wherein the forming stations in each row or line are motor-driven for movement transversely to the forming section, wherewith an edge cutter is allocated to each row of forming stations and connected to the first forming station such as to be movable together with said station. The invention is defined in the accompanying Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 is a top view of one example of a roll-equipped sheet forming machine according to the invention.
- Figure 2 is a side view of the same machine.
- Figure 3 illustrates an example of a sheet profile that can be obtained with the machine shown in Figures 1 and 2.
- Figures 4, 5 and 6 are respectively fragmented sectional views of parts of the machine show in Figures 1 and 2, said views being taken respectively on lines 4-4, 5-5 and 6-6 in Figure 1. Figure 5 is also a sectional view taken on the line 5-5 in Figure 11.
- Figure 7 corresponds to part of the Figure 1 illustration, although some features are shown in different positions.
- Figures 8-10 correspond to Figure 7 and illustrate different phases in a sheet roll-forming operation.
- Figure 11 is a top view of a roll-forming section that is, according to the invention, an alternative to the roll-forming section shown in Figures 1 and 2.
- Figure 12 is a side view of the roll-forming section shown in Figure 8.
- Figure 13 is a cross-sectional view taken on the line 13-13 in Figure 11.
- Figure 14 is a sectional view taken on the line 14-14 in Figure 13.

- Figures 15 and 16 illustrate examples of roofing sheet that can be produced with a machine that includes the roll-forming section shown in Figures 11-14.

DESCRIPTION OF TWO ILLUSTRATED AND PREFERRED EMBODIMENTS

Shown in **Figures 1 and 2** is a roll-forming machine that includes a device 11 for unwinding strip 10 from a metal strip reel 12, said strip being comprised, for instance, of steel, copper, zinc or aluminium Also included is a strip aligning device 14, which also functions to advance the strip, a sensor or detector 16 that measures the length of advanced strip, two short roll-forming parts 17, 18 and a cutter 19. The roll-forming sections 17 and 19 function to make two parallel grooves 21 and 22, 23 respectively in the sheet 10, as shown in **Figure 3**. Either one, or both, of said sections 17, 18 can be made inoperative, by mutually separating rolls in said sections. Figure 3 shows the finished sheet profile, which includes upstanding side-edges 25, 26 which are terminated with semi-circular dome-like structures 27, 28, said structures being dimensioned so that the smaller structure will fit into the larger structure. The smaller of these dome-like structures, i.e. the structure 28, has a seal-accommodating groove 29 and the structures are sealingly interlocked with the aid of a seaming machine, subsequent to covering a roof. The sheets are secured to the roof with clamps that extend up into the seams and therewith interlocked. These clamps are screwed to the roof, meaning that the sheets are completely devoid of screw holes.

The forward end of a forming section 30 for forming the side edges 25, 26 of the sheet and shaping said dome-like structures 27-29 is in immediate connection with the cutter 18. The section 30 includes two longitudinally extending forming-station carriers 31, 32 such as to form a sheet section between the carrier-supported forming stations. The carrier 32 is shown in Figure 2. It will be seen that the carrier 32 is supported on four transverse guides 33a-d on an intermediate part 34, such as to enable the carrier to be displaced at right angles to its longitudinal axis and also to the longitudinal axis of the intermediate part. In turn, the intermediate part 34 is pivotally mounted to the fixed chassis 35 on a pivot attachment 36 and rests on three slide strips 37a-c. The intermediate part 34 and the carrier 32 can thus be swung as a unit about the pivot attachment 36, and the carrier 32 can be moved on the intermediate part 34 at right angles to its longitudinal axis. These movements are effected with the aid of motors and are controlled by a computer. In order not to

complicate matters, the strip 10 is not shown in the forming section 30 in Figure 1, although it is shown in Figure 2.

The forming station carrier 31 is supported in the same way as the forming station carrier 32, and its pivot attachment 38 is indicated in Figure 1.

Each of the forming station carriers 31, 32 carries four groups 40-43 and 44-47 respectively, with three pairs of forming stations each having forming rolls on free shafts, i.e. on shafts supported on one side. Each group has a motor for driving all three forming stations in the group. This drive is conventional and is therefore not shown. The figures show all roll shafts 71 in the absence of forming rolls; all that is shown on respective roll shafts is an end plate which functions to lock the forming rolls securely to their respective shafts.

Figures 4 and 5 are fragmentary views of mutually opposing pairs of such forming stations. Figures 1 and 2 show all roll shafts 71 in the absence of forming rolls. The forming rolls 67-70 and 72-75 are shown fitted to respective shafts 71 solely in Figures 4 and 5. Figure 4 shows the first pair of forming stations 50, 51 in the first groups 40, 44, and Figure 5 shows the last pair of forming stations 52, 53 in the last groups 41, 45. Figure 5 is fragmentary and shows only the forming rolls and motors 76, 77 and belt drives that drive the rolls. Figure 4 shows corresponding drive motors 78, 79 and belt drives.

The first group of forming stations 40, 44 situated on each side function to form grooves that extend parallel with the edges of the sheet. This group can be used as an alternative to or together with one of the units 17, 18 that form grooves which extend parallel with the symmetry line of the sheet. The remaining groups 41-43 and 45-47 are used to form the upstanding side edges 25, 26. Not all of the various pairs of forming stations are completely opposite one another, but are mutually offset in a zigzag fashion, so as not to interfere with each other when producing narrow sheet profiles. The fact that the forming stations have free roll shafts, i.e. that are supported only on one side, enables the roll shafts to be inclined. In turn, inclination of the roll shafts enables the forming rolls to have a relatively small diameter and a simple form, therewith enabling the roll pairs to be close

together and in a mutually offset pattern, so that the entire roll forming section will be short.

Mounted on the carriers 31, 32, upstream of the first forming station pair 50, 51, is a pair of edge cutters 58, 59 which accompany movement of the first pair of forming stations 50, 51 both with respect to angular settings and also with respect to parallel movement towards and away from each other, i.e. parallel movement towards and away from the centre line of the forming section and therewith also the centre line of the sheet path. The edge cutters may be comprised of circular shears. Figure 2 shows a severed edge 65.

Downstream of the last pair of forming stations 61, 62 is a pair of profile cutters 63, 64 which are mounted on the carriers 31, 32 so as to follow the angular setting and parallel movement of the last pair of forming stations, so as to accompany the first pair of forming stations 50, 51, in a way similar to the edge cutters 58, 59. The upstanding side edges 25, 26 of a finished profile can be cut in the profile cutters 63, 64, as shown in **Figure 6**.

The cutter 18 is a parallel cutter with convex cutting blades such that the blade-overlap increases from the centre. Thus, the cutting length can be varied and there can be made in the strip or sheeting a cut that terminates short of the edges, by appropriate adjustment to the length of cutting stroke. Alternatively, the strip can be severed completely.

Figure 1 shows the forming section 30 when set for profiling metal sheet of constant profile width. It may then be advantageous to profile continuous strips and cut the strip into sheet form after profiling the strip. This gives greater measurement accuracy with respect to the end of the sheet. In this regard, the cutter 18 is caused to make a cut that terminates short of the edges of the strip, whereafter the edges are cut to a finished profile by the profiling cutters 63, 64, as shown in Figure 6. The commencement and termination of the cutting operations are controlled by a computer to which the length measuring sensor 16 is connected. The edge cutters 58, 59 need not be used, when the strip 10 has the correct width and also fine edges,. However, a slightly wider strip can be used and narrow strips cut from the edge of the strip, so as to ensure that a fine edge is obtained. A severed edge 65 is shown in Figure 2.

Figure 7 shows the forming section adapted to shape the so-called conical sheet, i.e. sheets that narrow towards one end. The rear end of the carriers 31, 32 are swung-out symmetrically from one another, by having swung the intermediate parts 34 in their respective pivot attachments and locking said parts in their angular settings.

Roll-forming of a sheet is commenced with each intermediate part 34 swung in its pivot attachments 36, 38 and sliding on their respective slide strips 37a-c, such that the forming stations will be adapted to first shape the widest end of an individual sheet. This angular setting is locked. The sheet 10 is fully severed in the cutter 18 to obtain a separate sheet 66 that is fed into the forming section, as shown in **Figure 8**. As the sheet 66 is fed into the forming section 30 by the strip aligning device 14, the carriers 31, 32 are moved in parallel symmetrically in towards the centre line of the forming section, with the aid of ball-screws (not shown), so that the edge cuts 58, 59 will cut away continuously increasing edge strips and therewith continuously reduce the width of the sheet. **Figure 9** shows the sheet 66 when it is midway in the forming section, and **Figure 10** shows the sheet 66 upon its exit from said section. The speed at which the sheet 66 is advanced and the speed at which parallel movement of the carrier 32, 33 takes place must be adapted so that each forming roll of the various forming stations will work in the correct groove on the narrowing strip. This process is controlled by a computer connected to the sensor 16 and to sensors (not shown) that detect width positions of the carriers 31, 32.

When the sensor 16 delivers a signal indicating that the strip shall be cut, the computer stops all advancement of the strip and the strip is cut in the cutter 18. The feed and forming of the severed sheet is then resumed until forming of the sheet has been completed, whereafter the formed/shaped sheet is discharged from the forming unit 30.

When forming of a sheet that has been cut from the strip is finalised, the measurement accuracy of the end of the sheet is worse than when a sheet is cut from a ready shaped strip. When desiring to improve the measurement accuracy with respect to said end, a cut which terminates short of the edges can be made with the cutter 18 and the strip then advanced through a distance of, e.g., 1-2 dm, after which the strip is severed completely. The strip is then advanced through a further 1-2 dm and a further cut that terminates short of the edge is made. The profile cutters 63, 64 can then be used to sever the sheet

completely in line with the two aforesaid cuts, and therewith improve end accuracy. This results in improved accuracy with respect to both ends, at the cost of a piece of scrap of less than 0.5 metre between two sheets and also at the cost of a slightly lower production rate due to stoppages.

In order to produce sheet that has a pronounced taper and that is very narrow at one end, it may be necessary to divide the carriers so that rear carrier parts with the last two groups 42, 43, 46, 47 of forming stations on each side can continue to be moved in towards each other when the sheet has left the first two groups 40, 42, 44, 45 of forming stations and the front parts of the carriers cannot be moved closer together.

Figures 7-10 illustrate roll-forming of sheet that tapers towards one end, wherewith the widest part of the sheet is roll-shaped first. However, it is, of course, possible to roll-shape the narrowest end first. This may be an advantage when the machine is placed on the roof to be covered, close to the base of the roof, and when roll-forming roof plates that are several tens of metres in length and roll-forming the sheet upwardly towards the centre of the roof, since the plate will then have the correct end upwards.

The length of the illustrated machine may be sufficiently short to enable the machine to be embodied in a freight container of standard size, i.e. 12 m x 2.4 m, and the container lifted together with the machine by a crane onto the roof to be covered with roof sheeting. A diesel-driven electrical power plant may be built into the container, so that the machine will be self-sustaining. The invention is not restricted to machines for profiling roof sheeting with standing seams, but can also be used for other kinds of roll-forming.

Figures 11 and 12 illustrate a roll-forming section 90 which is modified version of the roll-forming section 30 of the preceding figures. The forming section 90 includes four groups 91-94 and 95-98 respectively of forming stations on each side of the sheet section, similar to the earlier described embodiment. In this embodiment, each group has a carrier which is movable in parallel and the angulation

of which can be adjusted individually. The carriers 100, 101 (corresponding to the carriers 31, 32 in Figures 1-2) in the first groups 91, 95 each carry a respective edge cutter 102, 103, in addition to carrying three forming stations 104-109. Because each group 91-98 can

be adjusted individually, it is not only possible to work towards one end of tapering sheets, but also to produce sheets that include selective curve shapes within given limits, therewith providing the architects with a high degree of freedom in, for instance, drawing dome-like roof structures that have either a constant or a varying radius of curvature. **Figures 15 and 16** illustrate examples of roof sheets for dome-like roofs that can be produced in the roll-forming part 90. The roof plates include grooves 120, 121 which extend parallel with the edges of said sheets, i.e. grooves made in the first groups 91, 95 of forming stations in the forming section 90. The edge cutters 102, 103 always move in unison with the first pair of forming stations, and this forming section can also be coupled directly to a device for unreeling strip, as in the earlier described embodiment.

Figure 13 illustrates the first pair of forming stations 104, 107 in the first group 91, 95. The forming rolls have been identified by the same reference signs 67-70 as those used in Figure 4, since these rolls are similar to those illustrated in said figure. Because of the existing symmetry, only the forming station 104 is described. The forming rolls 69, 70 are carried by the carrier 100, which is attached to a pivot attachment 111 (**Figure 14**) on an intermediate part 112. The intermediate part 112 is carried displaceably by slide bars 113, 114 on the fixed chassis (stand) 115, and can be moved by means of a motor 116 and a ball-screw 117. The carrier 100 can be pivoted on the intermediate part 112, by means of a motor 118 and a ball-screw 119. Figure 4 shows two alternative angular positions of the carrier 100 in chain lines.

Thus, the angle of the carrier 100 can be adjusted in relation to the longitudinal axis of the forming section, and the carrier can also be moved in parallel transversely to said longitudinal axis, such as to enable simultaneous movement and angular adjustment of the forming stations carried thereby. Each group of forming stations is movable individually in this way, meaning that it is also possible to produce sheets having curved edges and varying radius of curvature on each individual sheet, in addition to producing sheets with straight edges. Because each group includes more than one forming station and because said stations are commonly supported by one carrier, it is only possible for one of the forming stations in each group to follow precisely the correct groove, although in the case of reasonable curve radii the error will only be in the order of magnitude of one millimetre. Such an error will not disturb the function. In the case of small radii of curvature, it is

necessary for each forming station to be adjustable individually. However, it is possible in practice to adjust the settings of two or more forming stations in common, as shown.

CLAIMS

1. A roll-forming machine which includes in line a device (11) for unwinding metal strip (10) from a strip-carrying reel (12), a cutter (18) for cutting the strip, and a forming section (30; 90) which forms a sheet path, **characterised** in that the forming section (30; 90) includes a row of forming stations (50, 51, 52, 53; 104-109) that have forming rolls (67-75) on a one-sided supported shaft (71) on each side of the sheet section, wherein the forming stations in each row can be moved across the forming section by motorised drive means, and wherein an edge cutter (58, 59; 102, 103) is allocated to each row of forming stations and is coupled for movement together with the first forming station.

2. A machine according to Claim 2, **characterised** in that the edge cutter (58, 58; 102, 103) and the first forming station (50, 51; 104, 107) in each row of forming stations are mounted on a common, movable carrier (31, 32; 100, 101) for movement in unison with one another.

3. A machine according to Claim 1 or 2, **characterised** in that each row of forming stations, several forming stations in the row are mounted on a carrier (32, 32; 100, 101) whose angle relative to the longitudinal axis of the forming section can be adjusted and which can also be moved in parallel transversely to said longitudinal axis, such as to obtain simultaneous movement and angular adjustment of said forming stations.

4. A machine according to Claim 3, **characterised** in that each row of forming stations includes several carriers (31, 32; 100, 101) in line, said carriers each carrying two or more forming stations and being movable individually.

5. A machine according to Claim 3, **characterised** in that all forming stations in each row are mounted on a common carrier (31, 32).

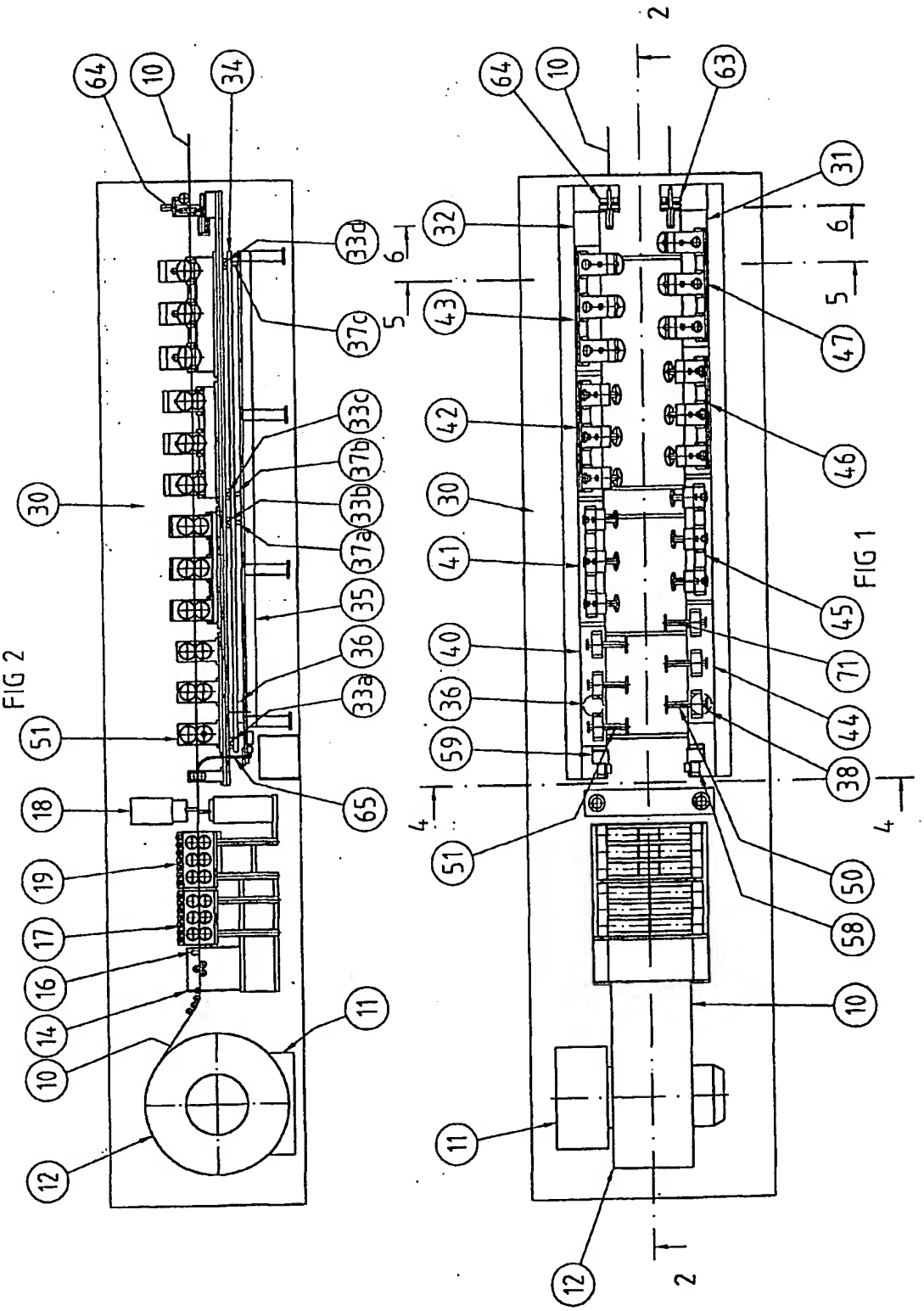
6. A machine according to any one of the preceding Claims, **characterised** in that at least a part of the forming stations in the two rows of forming stations is placed so that the forming rolls (67-75) on one side are offset in relation to the forming rolls on the other side.

7. A machine according to any one of the preceding Claims, **characterised** in that at least a part of the forming stations has forming rolls (67-75) mounted on sloping shafts.

8. A machine according to any one of the preceding Claims, **characterised** in that the cutter (18) has cutting edges that are convex towards the centre, and in that said cutter has a variable length of stroke so that it can make cuts in the planar centre portion of the strip to a varying extent towards the edges of the strip and, alternatively, completely sever the strip.

9. A machine according to any one of the preceding Claims, **characterised** in that cutters (63, 64) which have profiled cutting edges are disposed downstream of the last forming station.

10. A machine according to any one of the preceding Claims, **characterised** in that the machine is embodied in a freight container.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37b
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FIG 2
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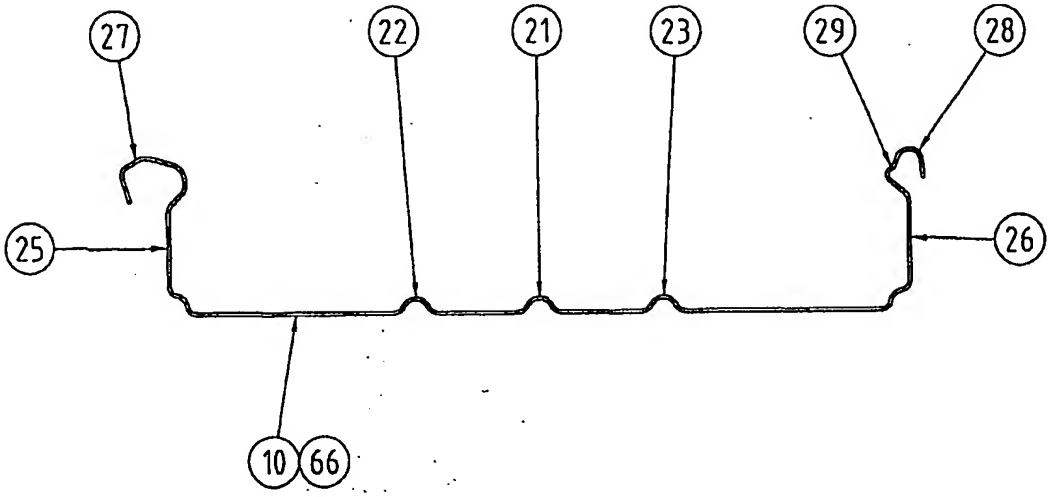
FIG 1

FIG 3



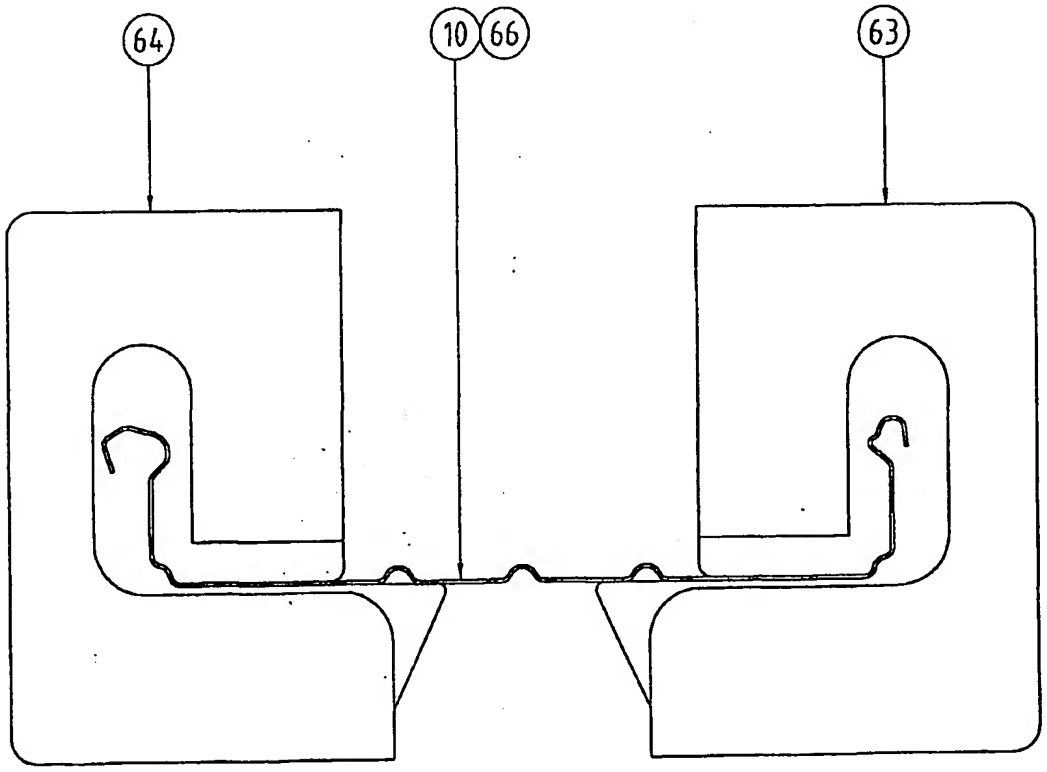
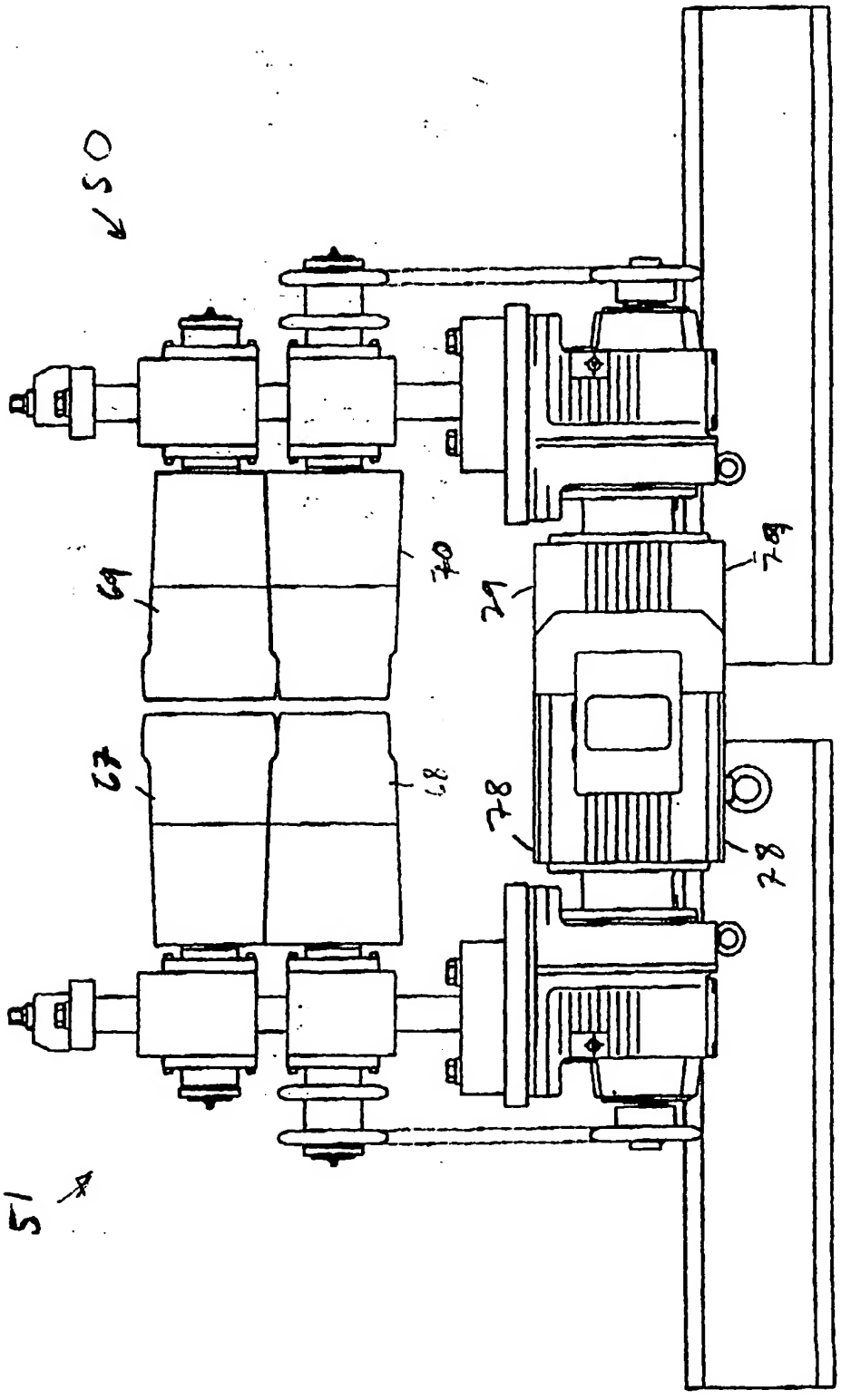


FIG 6

FIG 4



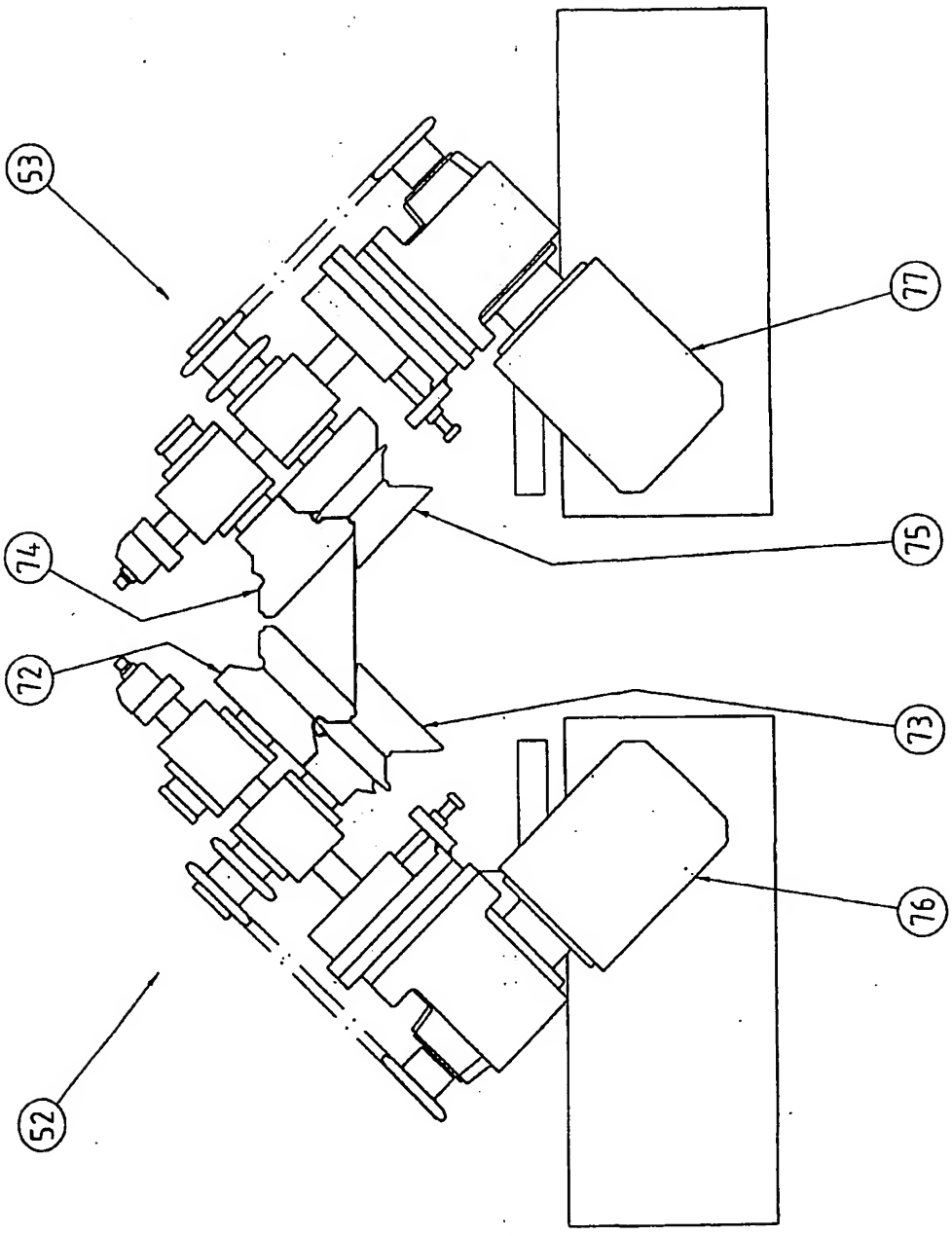


FIG 5

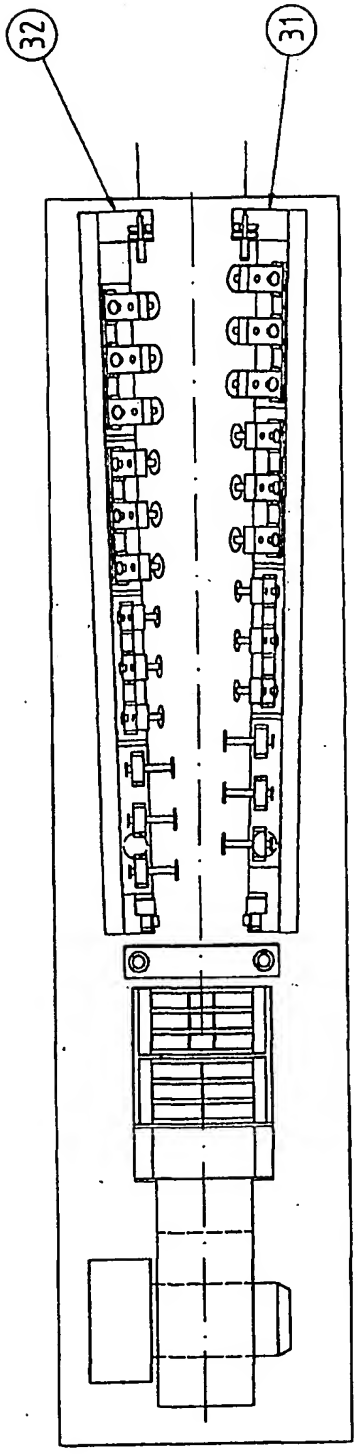


FIG 7

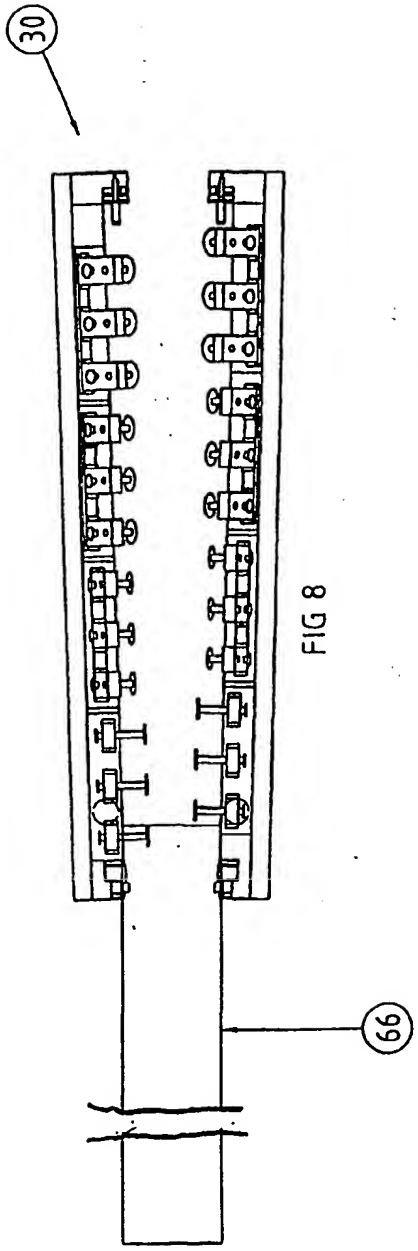


FIG 8

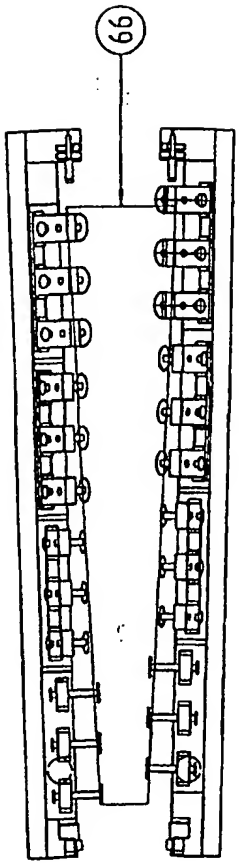


FIG 9

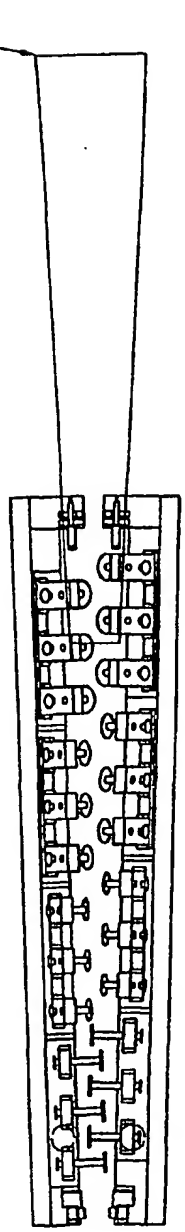


FIG 10

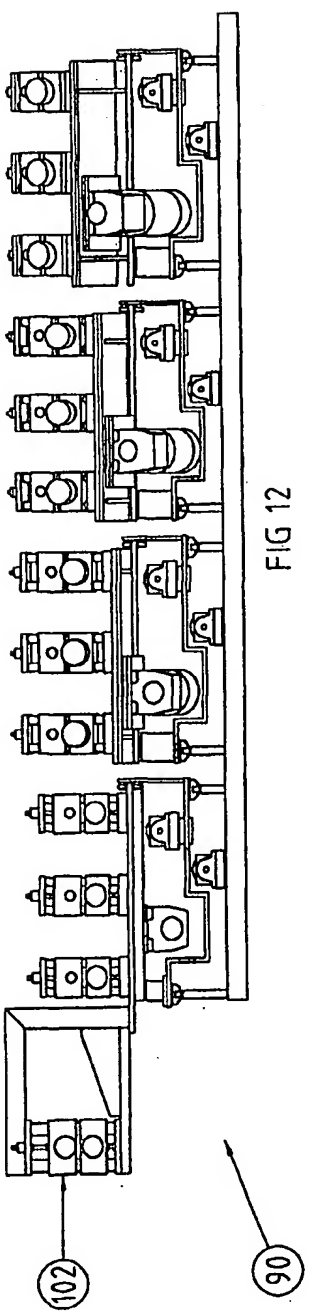


FIG 12

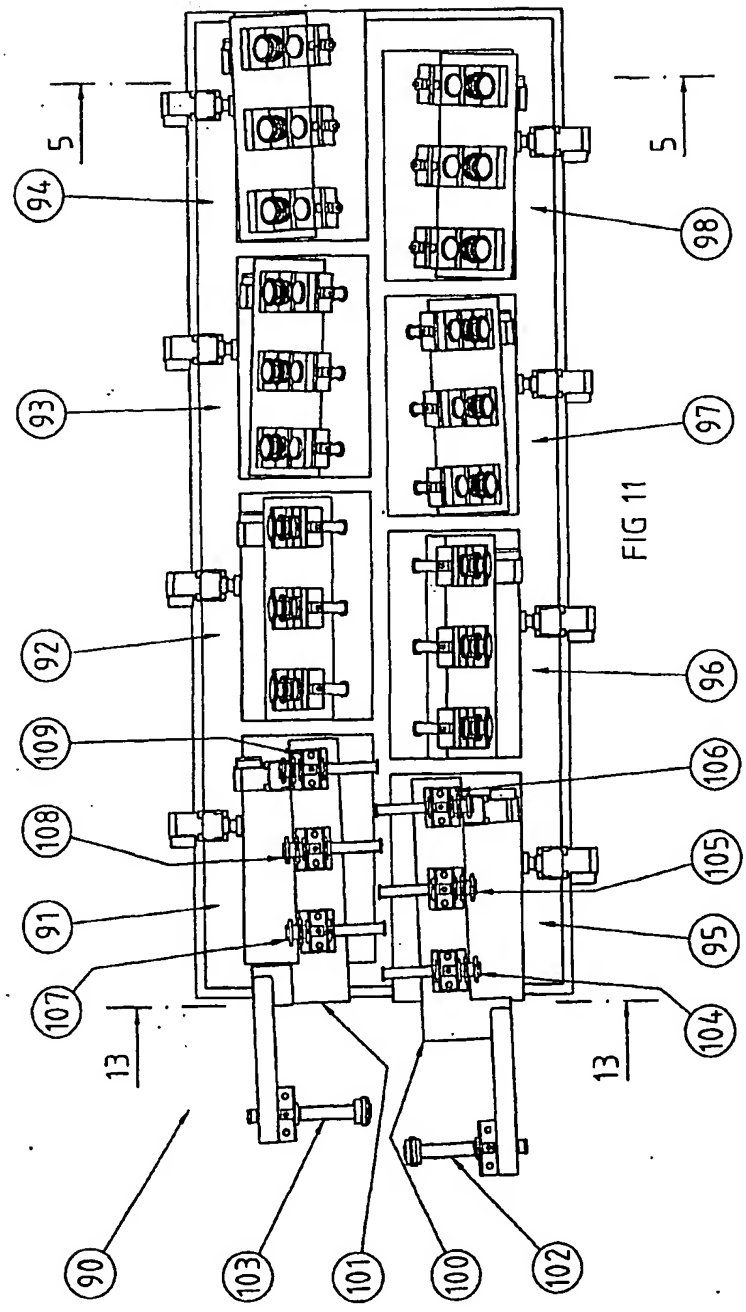

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FIG 11

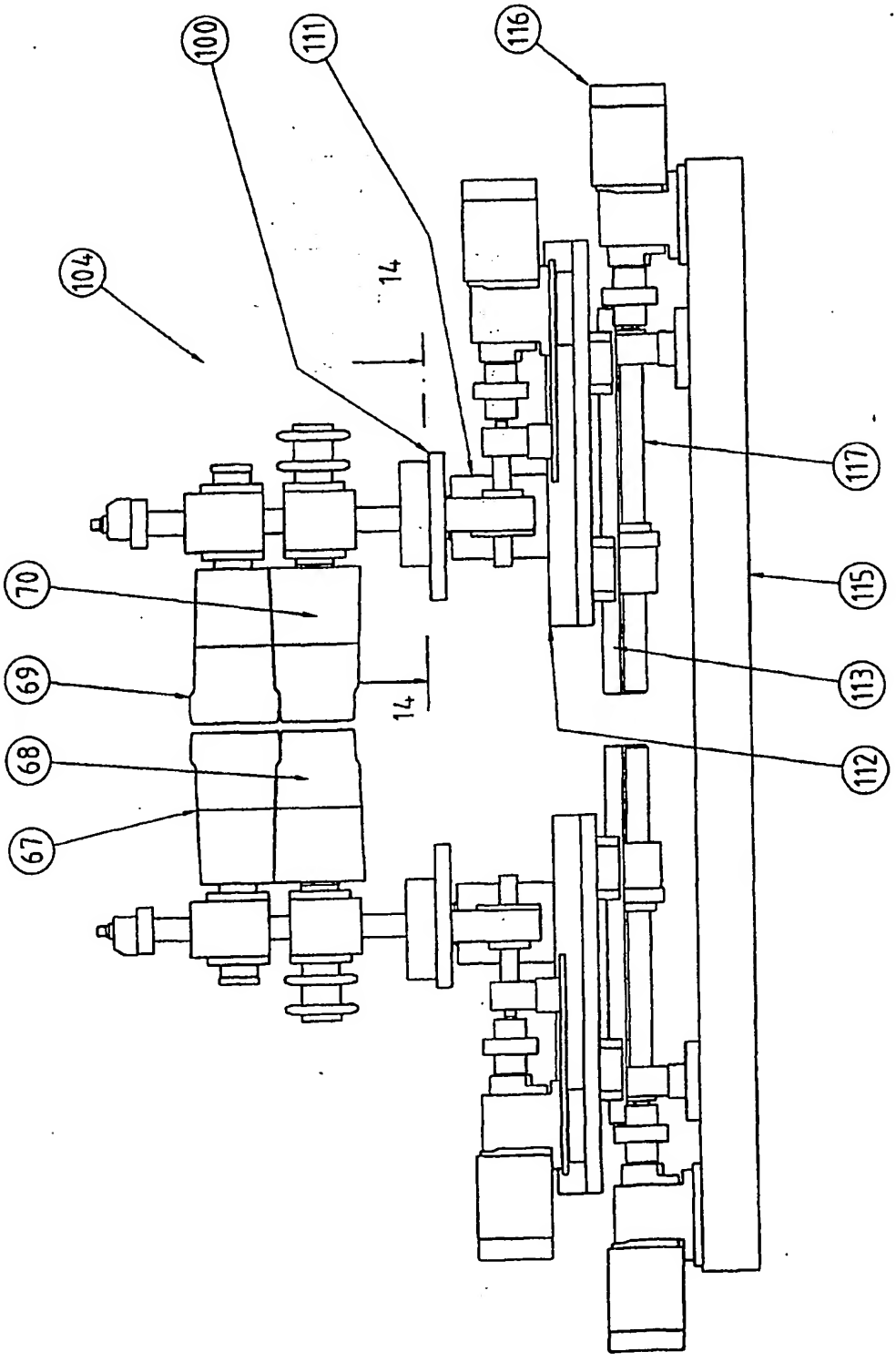

FIG 13

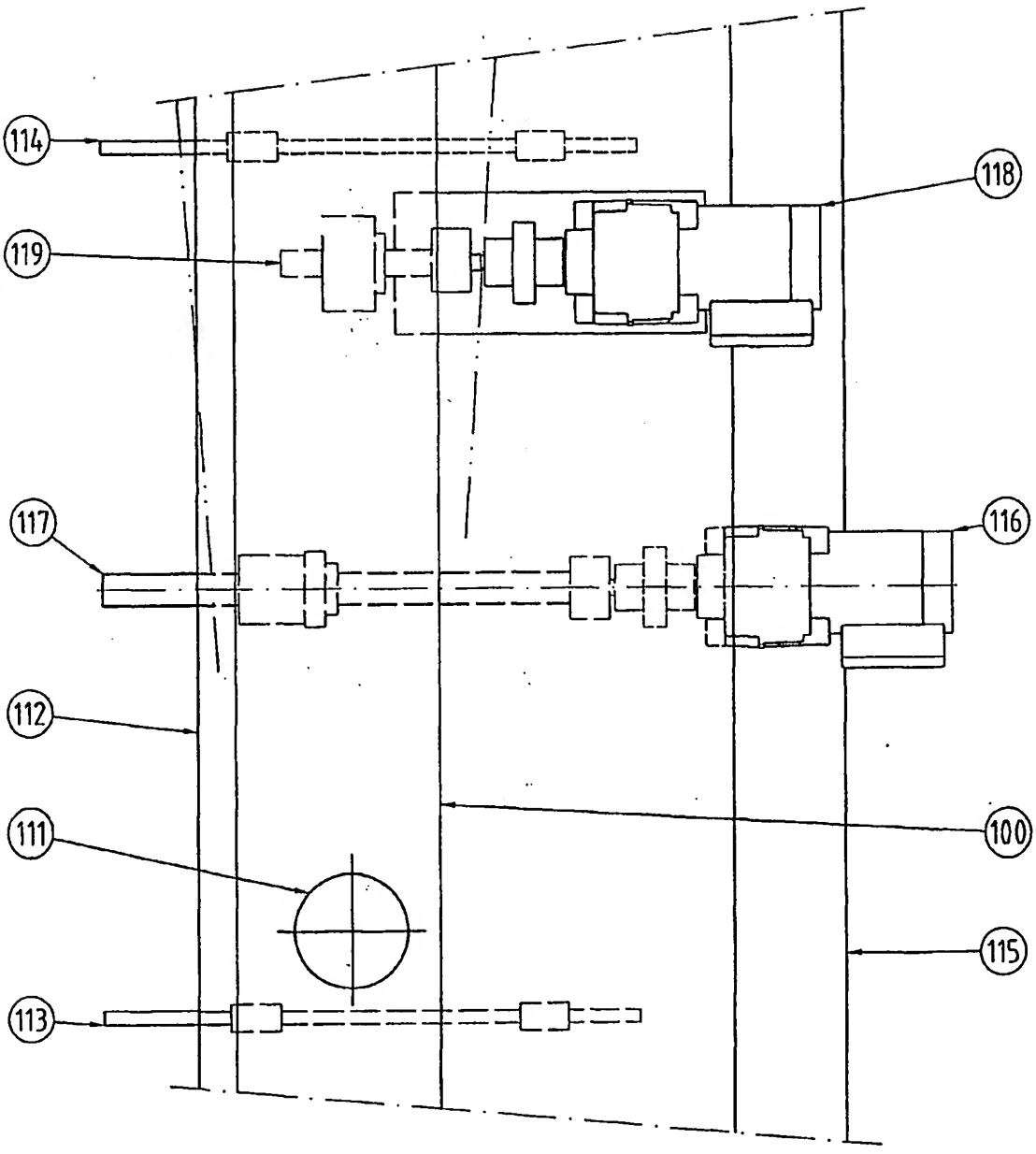

FIG 14

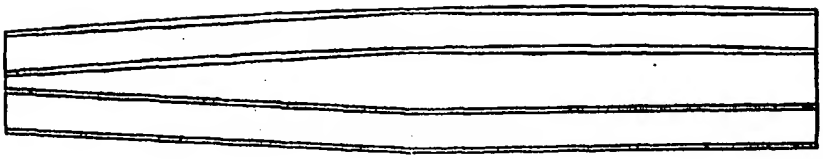

FIG 15

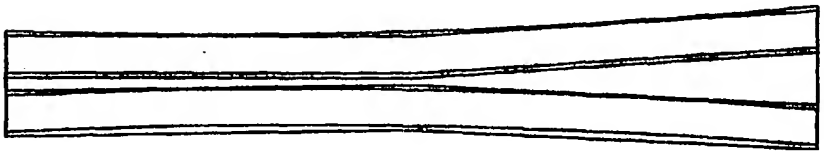

FIG 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02601

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B21D 5/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WPI/Derwent's abstract, Accession Number 1997-196573, week199718, ABSTRACT OF JP 9052125 A, (NAKAMURA SEISAKUSHO CO LTD) 25 February 1997 (25.02.97). Figures 1-3; abstract	1-9
Y		10
X	AU 199859441 B2 (BHP STEEL (JLA) PTY LTD.), 1 October 1998 (01.10.98), figures 1-2, abstract	1-9
Y		10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 March 2002	11-03-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Fredrik Strand/MP Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 8701977 A1 (GOMERA PTY. LTD.), 9 April 1987 (09.04.87), figures 1-6, abstract	10
A	abstract	1-9
A	File EPODOC/EPO,MAKOTO SEIKI KK "ROLL FORMING APPARATUS", JP 56056729 A, 1981-05-18; figures 1,4,5	1-10
A	US 6115899 A (TERRY L. RIDER), 12 Sept 2000 (12.09.00), figures 1-2, abstract	1-10
A	US 4918797 A (NEIL A. WATKINS ET AL), 24 April 1990 (24.04.90), figures 1-2,7-9, abstract	1-10
A	US 5315853 A (BRIAN L. SCHEITERLE), 31 May 1994 (31.05.94), figure 2, abstract	1-10
A	US 3931725 A (ROBERT E. YON), 13 January 1976 (13.01.76)	1-10

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Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

The separate inventions are:

1. Claims 1-9 are directed to a roll-forming machine for sheet steel.

2. Claim 10 is directed to a freight container for a roll-forming machine.

The common features of invention 1 and invention 2 are stated in claim 1. The features, directed to a roll-forming machine for sheet steel, are disclosed by documents JP 9052125 and AU 734061 respectively.

Since the common features of the two inventions do not make a contribution over the prior art, it appears that (a posteriori) claims 1-10 do not satisfy the requirements of unity of invention according to PCT rule 13.

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.
PCT/SE 01/02601

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
AU 199859441 B2	01/10/98	NONE	
WO 8701977 A1	09/04/87	AU 6545286 A	24/04/87
US 6115899 A	12/09/00	NONE	
US 4918797 A	24/04/90	NONE	
US 5315853 A	31/05/94	NONE	
US 3931725 A	13/01/76	NONE	